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Research Article

Effect of *Azotobacter* and PSB Inoculation on Nitrogen Uptake by Lettuce

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ABSTRACT

The present investigation entitled "Effect of Azotobacter and PSB inoculation on nitrogen uptake by lettuce. (Lactuca sativa L.)" was carried out at Department of Plant Pathology, College of Agriculture, Pune in view to study their effect on growth parameters and nutrient uptake by lettuce crop. There were seven treatments, including seed treatment with liquid Azotobacter and liquid PSB @ 25 ml/kg of seed; Foliar spray of liquid Azotobacter and PSB @ 25ml/lit, in alone and in combination; respectively. Results revealed that application of liquid bioinoculants significantly increase nitrogen uptake by lettuce crop over uninoculated control and ranged from 0.25 g to 0.62 g. Whereas seed treatment with liquid Azotobacter + Foliar spray of liquid Azotobacter was superior for soil Azotobacter population and available soil nitrogen and seed treatment with liquid PSB + foliar spray of liquid Azotobacter was superior for soil PSB population and available phosphorus, over uninoculated control. Considering all these parameters, it could be concluded that liquid Azotobacter and PSB improved soil biochemical properties which may ultimately influence the growth of lettuce.

Key words: *Azotobacter, PSB, Nutrient uptake, Soil biochemical properties*

INTRODUCTION

Liquid biofertilizer technology is an alternative solution to carrier based biofertilizers. It comprises aids to preserving organism, to delivering them to their targets and improves their activities. These are special liquid formulation containing not only the desired microorganism and their nutrients but also special cell protectants or substances that encourage formation of resting spores or cyst for longer shelf life and tolerance to adverse condition. Unlike the lignite based biofertilizers, liquid biofertilizers have a longer shelf life (Rao, 2007). By applying an appropriate liquid biofertilizer, the overall cost of production will be much lower as compared to traditional chemical fertilizers (Chin, 2010).

Azotobacter is commonly found in rhizosphere and phyllosphere of plants and is very effective for the improvement of soil fertility and crop productivity.

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It can fix nitrogen directly from the atmosphere that helps plants for better grain production. Besides, nitrogen fixation, *Azotobacter* also produces growth hormones *viz;* thiamine, riboflavin, nicotine, indole acetic acid and gibberellins. Seed or soil inoculation with phosphate-solubilizing bacteria is known to improve solubilization of fixed soil phosphorus and applied phosphates resulting in improvement of plant growth performance and higher crop yield. Application of phosphorus along with phosphate solubilizing bacteria (PSB) improve P uptake by plants and yield indicating that the PSB are able to solubilize phosphates and to mobilize phosphorus in crop plants. Bio-fertilization with PSB could provide a better alternative for the extensive use of phosphate fertilizer in crop production (Rogers *et al.* 1993).

An application of biofertilizer to seeds improves its germination to a considerable extent, controls plant diseases infection due to antagonistic nature as well as improves nutrient uptake. Considering the adverse effect of chemical fertilizers, the bio-fertilizers are economically cheaper and work as eco-friendly. In view of this background information, the present experiment was undertaken to study the effect of *Azotobacter* and PSB inoculation on growth parameters and nitrogen uptake by lettuce crop.

MATERIALS AND METHODS

Seed inoculation

For inoculation of liquid *Azotobacter*, the seeds of lettuce were dipped in liquid *Azotobacter* suspension @ 25ml/kg of seeds and seed treatment with liquid PSB was given by dipping seeds in liquid PSB suspension @25 ml/kg.

Methods used for soil Analysis:

Soil sample were collected and analyzed to study chemical and biological properties of soil.

Table 1: Analysis of soil samples

Sr. No.	Parameter	Method	Reference
1	Available Nitrogen	Alkaline permagnate method	Subbiah and Asija, (1956)
2	Available phosphorus	0.5 M NaHCO3 Olsen‟s method	Olsen*et al.*(1965)
3	Available Potassium	Ammonium acetate extraction method	Knudsen *et al.* (1982)

Methods used for plant analysis

Collected plant sample were analyzed for chemical properties i.e. nitrogen per cent and nitrogen uptake by plant by using Kjeldhal's method.

Table 2: Analysis of plant samples

Parameter	Method	Reference
Total Nitrogen (%)	Kjeldhal's method	Parkinson and Allen,

RESULTS AND DISCUSSION

Effect of liquid *Azotobacter* and PSB inoculation on nitrogen uptake

The nitrogen uptake in lettuce was significantly increased over uninoculated control and ranged from 0.25g to 0.62g. Significantly highest nitrogen uptake was observed with application of seed treatment with liquid *Azotobacter*@ 25 ml/kg + foliar spray of liquid *Azotobacter*@ 25 ml/lit (0.62g) these was superior to all other treatments and uninoculated control (0.25g).

The results similar to that of Patil (1990) who noted that the seed inoculation with *Azotobacter* alone and combined application of three doses of fertilizers were beneficial to increase the uptake of nitrogen in sorghum. Narula *et al.* (2000) inoculated with

Azotobacter chroococcum and showed greater N uptake and also reported more growth hormone production than the soil isolates. Kedar *et al.* (2002) concluded that due to using *Azotobacter* inoculants total N uptake increase significantly only over the control. The highest N uptake (23.17 mg plant-1) was recorded with *Azotobacter* inoculants treatment and lower with the control (11.03mg plant-1). Shriram and Prasad (2001) reported that application of 80kg N ha -1 along with biofertilizers and growth regulators increased the nutrient uptake of seed cotton. Singaravel *et al.* (2008) studied the effect of different liquid biofertilizers on the uptake of N by okra and they found increase in the nitrogen uptake.

Table 3: Effect of liquid *Azotobacter* and PSB inoculation on the nitrogen uptake (g plant-1) in lettuce

Treatment	N conc. (%)	N uptake (g plant-1)
T1	3.50	0.38
T2	3.30	0.28
T3	3.90	0.50
T4	3.43	0.33
T5	3.37	0.39
T6	4.10	0.62
T7	3.10	0.25
SE ±	0.06	0.013
C.D. (0.05)	0.17	0.041

Effect of liquid *Azotobacter* and PSB inoculation on chemical properties of soil

Available nitrogen content in soil at harvest (kg/ha)

The available nitrogen (kg ha-1) in soil increased at harvest when compared to initial nitrogen status of soil and showed significant increase in its available status at harvest. The statistically significant difference between initial and harvest soil status of available nitrogen was recorded in seed treatment with liquid *Azotobacter*@ 25 ml/kg + foliar spray of liquid *Azotobacter* @ 25 ml/lit (195.30 kg ha-1) over uninoculated control (177.60 kg ha-1). The available nitrogen in soil increased, this may be occurs due to more root exudates are being secreted during grand growth period of crop which increase bacterial population and nitrogen fixing efficiency of biofertilizers. The earlier reports on increase in nitrogen content due to *Azotobacter* inoculation also support the findings of present investigation. The increased in available nitrogen to 50 per cent in chilli have been reported by Agnihothrudu *et. al*. (1983). Patil (1990) noted that the seed inoculation with *Azotobacter* alone and combination of three doses of fertilizers were beneficial to increase the uptake and residual N, P and K on sorghum. Narula *et al*. (2000) inoculated mutant strain of *Azotobacter chroococcum* and showed greater N, P and K uptake and also reported more growth hormone production than the soil isolates. Kapure and Naik (2004) studied the effect of biofertilizers i.e. Vitromone, Bioplin (inoculants of *Azotobacter* spp.) along with pure culture of *Azotobacter* significantly improved the nitrogen content in soil of chickpea.

Available phosphorus content in soil at harvest (kg/ha)

The available phosphorus (kg ha-1) in soil increased at harvest when compared to initial phosphorus status of soil and showed significant increase in its available status at harvest. Significantly highest available phosphorus content (17.44 kg ha-1) was observed in seed treatment with liquid PSB @ 25 ml/kg + Foliar spray of liquid *Azotobacter* @ 25 ml/lit over uninoculated control (15.36 kg ha-1), followed by seed treatment with liquid *Azotobacter* @ 25 ml/kg + Foliar spray of liquid *Azotobacter* @ 25 ml/lit (15.34 kg ha-1).

The available phosphorus in soil was increased significantly due to liquid

formulation of PSB seedling inoculation over the absolute control. This may results due to the root exudates secreted during grand growth period of the crop which increases the phosphate solubilization efficiency of the bacteria which makes the insoluble form of P into soluble form to make available for plants uptake. The findings by Afzal and Bano (2008) revealed that inoculation of phosphate solubilizing bacteria and *Rhizobium* with fertilizer (P2O5) significantly increased the insoluble P reservoir and phosphorus content in plant. This increased available phosphorus in soil, reflected in its uptake by plants. Increase in phosphorus uptake following seed inoculation has been reported by several workers. Mahdi *et al.* (2010) reported that, use of phosphate solubilizing bacteria as inoculants increases phosphorus solubilization and decrease the initial status of P content in soil similar results by Yousefi (2012). Yogita and Ram (2012) finding revealed inoculation of biofertilizers and application of inorganic fertilizers the maximum availablility of P for plant uptake and increases the yield of onion. The increase in the P uptake due to inoculation with P solubilizing microorganisms has been reported in pigeon pea (Modak *et al*. 1993). The present investigations are in close conformity with the earlier worker.

Available Potassium content in soil

It was observed that available potassium content of soil at initial was found higher than available potassium content of soil at harvest. The results clearly indicated that there was no effect of bioinoculants inoculation on potassium content of soil at harvest. However, there are no reports found on the effect of liquid *Azotobacter* and PSB inoculation on influencing available potassium status of soil.

Table 4: Effect of liquid *Azotobacter* and PSB inoculation on available N, P and K (kg ha-1) content in soil at harvest

Treatments	Available in kg ha-1		
	N	P	K
T1	193.90	15.35	254.30
T2	185.20	17.08	255.60
T3	187.10	17.06	251.40
T4	189.60	16.94	259.80
T5	193.10	17.44	255.50
T6	195.30	15.34	256.10
T7	177.60	15.36	267.60
SE ±	1.02	0.51	0.77
C.D. (0.05)	3.14	1.56	2.36
Initial value of soil NPK status	190.00	16.50	284.38

SUMMARY AND CONCLUSION

Application of liquid bioinoculants significantly increase nitrogen uptake by lettuce crop over uninoculated control and ranged from 0.25 g to 0.62 g. Whereas seed treatment with liquid *Azotobacter* + Foliar spray of liquid *Azotobacter* was superior for soil *Azotobacter* population and available soil nitrogen. While seed treatment with liquid PSB + foliar spray of liquid *Azotobacter* was superior for soil PSB population and available phosphorus, over uninoculated control.

Thus, the above studies indicate that the liquid *Azotobacter* and liquid PSB were shows positive effect in respect of nitrogen uptake by plant, which ultimately influence the growth and yield of crop.

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